

# **ATTACHMENT 2**

## **GENERAL CONSTRUCTION REQUIREMENTS**

This Attachment contains general requirements that apply to all Contract Work unless superceded by more detailed specification requirements stated in specification Work Items.

### **1. GENERAL**

- A. The Vessel is not intended to be in ABS Class. However, the Technical Specifications may include references to ABS requirements. Where designs, processes, procedures and installation requirements are referred to ABS rules, the Contractor shall adhere to the requirements of the applicable ABS rules but is not required to obtain ABS approval, nor required to have ABS onboard inspection. Certain materials and equipment are indicated to be “certified” by ABS. Where the term “certification” is used, the Contractor shall obtain ABS approval and “Certification” for the noted material or equipment.
- B. The Contractor shall remove and relocate all interferences associated with all Work performed as part of this Contract. Equipment that cannot be replaced in its original location shall be relocated as approved by the WSF Representative.
- C. The equipment installed by the Contractor shall be located, supported, and connected so as to permit ready and safe access to all parts and components required for operation, inspection, service, maintenance and repair without disturbance of other structure or equipment.
- D. The Engineer’s Operating Station (EOS) and adjacent Engineer’s Dayroom are continuously manned spaces. Sound attenuation within these spaces shall not be compromised. The Contractor shall pay particular attention to providing an installation that minimizes sound paths between the Engine Rooms and the interior of the EOS and Dayroom.
- E. All fasteners used in weather areas shall be 316 stainless, grades 5 or better..
- F. ISOLATION
  - 1. The Contractor shall provide all labor, materials, and equipment to dielectrically and vibration isolate all new, relocated, and modified equipment to:
    - a) meet or exceed the original isolation for relocated and modified equipment and;
    - b) meet isolation requirements of the manufacturer for all new equipment installed by this Technical Specification..

## G. PENETRATIONS OF STRUCTURAL MEMBERS

1. Penetrations of structural members (beams, bulkheads, girders, etc.) for piping, ducting, cableways, or otherwise shall be kept to an absolute minimum, but where required, penetrations shall have compensation. Existing penetration holes or lightening holes shall be used whenever possible. Holes may be made in the web of a member only. Holes, scallops or other weakening of flanges in new or existing structure is not permitted under any circumstances.
2. All requests for penetrations through structural members not detailed in the Contract Drawings must be submitted to (along with sketches and calculations, as applicable), and approved, in writing, by the WSF Representative.
3. If a structural member has to be penetrated other than those shown on the Contract Drawings, or if an existing structural member penetration is modified in any way during the course of the Work, the construction drawings must depict the penetration with a detail of the penetration including cut size, location, and any strengthening in way of the cut. Location of penetrations and openings in structure, and associated stress concentration relief, shall be guided by Section 18 of Chapter 5 of the SNAME publication *Ship Design and Construction, 1969 Edition*. Calculations of the strength of the penetrated member shall accompany the drawing or sketch for penetrations and openings that do not conform to the above. This pertains to enlarging those openings shown on the Contract Guidance Drawings as well as to new openings.
4. The Contractor shall close-up all unused penetrations resulting from removed or rerouted piping, ventilation, and cableways and as required by Regulation for the required classification of the boundary. Existing “collared” penetrations through structural members need not be inserted unless the member forms part of a classified boundary. Penetrations, strengthening, and close-up shall be the responsibility of the Contractor.

## 2. ARRANGMENT

### A. ACCESS FOR MAINTENANCE

1. The machinery and equipment installed by the Contractor shall be located, supported, and connected so as to permit ready and safe access to all parts and components required for operation, inspection, service, maintenance and repair without disturbance of other structure or equipment. . The ability to quickly access RTD or thermocouple sensors without the necessity of cutting the cables shall be incorporated in the installation.
2. Access shall be by means of permanent ladders, walkways, platforms, doors, manholes, scuttles and/or bolted plates. Battens and gratings in storerooms and other spaces, and protective casings around pipes, shall be

made readily removable. Ladders shall be located in line with access openings.

3. All newly constructed or modified tanks shall be provided with access for cleaning and maintenance. Tank accesses shall be sized to allow easy visual inspection and a means of entry for maintenance, either through handholes or manholes, based on the tank size. All accesses shall be provided with proper gaskets, cover plates and corrosion resistant closure fasteners. Unless otherwise shown on drawings, provide 3/4 inch piping, valve, and plug for draining.
4. Restriction of existing access openings or soft patches by pipes, wireways, ventilation, maintenance pull spaces, valves, and the like is not permitted.
5. All trunks, casings and enclosures shall be large enough to facilitate servicing of piping, manifolds and similar appurtenances which may be contained in or pass through the space.
6. To facilitate inspection and maintenance of equipment having removable heads/sections or other major parts (including tube or tube bundle withdrawal), piping systems shall be designed and installed to permit access by disassembly of the equipment system's mechanical connections only. If this requirement is not possible, suitable piping takedown joints shall be provided. Heat exchanger tube bundle withdrawal zones shall be kept free of all other interference.

### **3. STRUCTURAL REQUIREMENTS**

#### **A. INTEGRITY**

1. Workmanship shall ensure that the requisite hull integrity is obtained, that exposed surfaces are smooth, and that proper fit and alignment are accomplished and maintained. Care shall be exercised to minimize stress concentrations and all structure shall be neatly fitted and finished. Cuts in structures and procedures for stress concentration relief shall be guided by USCG NVIC-7-68 (or current version).
2. The exterior of all new and replaced portions of the Vehicle Decks, Machinery Casings, Passenger Decks, weather decks, deckhouses, housetops, and associated weather boundary bulkheads shall be proven weather tight.
3. All Passenger and Crew Restroom perimeter bulkheads shall be proven fume tight unless otherwise specified.

4. New or repaired shell plating and new or modified watertight bulkheads shall be demonstrated to be watertight by air testing, or hose testing.

B. MATERIAL

1. All steel shall be new and, unless otherwise specified, shall be certified by the steel supplier to meet ABS Grade A or B as required for the service intended. The mill certification for all plate, structural shapes, and other structural material requiring certifications to be used in/on the vessel shall be provided. A copy of the mill certification for all plate to be used in the Vessel shall be provided to the WSF Representative prior to use of that steel on the Vessel. ABS Certification for all plates and structural shapes to be used on the vessel need not be obtained. However, the mill certification of physical and chemical properties that meet ABS criteria is required.
2. All new steel shall be wheel-abraded or grit blasted to a SSPC SP-10, Near-White Blast Cleaning, and immediately primed with weld-through primer that is compatible with the coating systems used on the Vessel. Where a sheet steel gauge is specified it shall be USS for plain steel and USSG for galvanized material. All temporary assembly clips and temporary padeyes shall be removed and the attachment welds ground smooth and/or gouges welded flush and ground smooth.
3. Workmanship shall meet SNAME standards of quality to ensure that the requisite hull integrity is obtained, that exposed surfaces are smooth, and that proper fit and alignment are accomplished and maintained. Care shall be exercised to minimize stress concentrations and all structure shall be neatly fitted and finished. Cuts in structures and procedures for stress concentration relief shall be guided by SNAME "Ship Design and Construction", 1969 Edition, Chapter IV, Section 18.
4. Pop rivets shall not be used in place of threaded fasteners without the prior written approval of the WSF Representative, or are specifically called for in a Work Item. All exterior fasteners shall be Type 316 stainless steel. All interior fasteners shall be corrosion resistant, grade 5 or better. All nuts shall be Nylok or equal, except for general lighting and main cableways.

C. ACCESS CUTOUTS

1. Provide shipping access cuts as required to remove, install, or reinstall equipment and items. Provide temporary shoring and stiffening as required to safely accommodate equipment removal and reinstallation, as well as for any other load handling operations that may be required. Provide temporary lifting padeyes as necessary to assist in removal, installation, and reinstallation of equipment, components, and machinery.
2. Submit three (3) copies sketches showing proposed access cutouts, temporary shoring and stiffening, and temporary padeye arrangements to the WSF Representative for review prior to accomplishment.

**NOTE:** WSF does not pre-suppose the Contractor's methods of getting machinery, equipment, and material to and/or from the installation site nor the attendant need for access cutouts.

3. Restrictions of access openings or soft patch areas by pipes, valves, wireways, or other interferences are not permitted.
4. Remove deck and bulkhead sections as required to remove large machinery and components and to install or reinstall new and/or repaired machinery and components. The corners of all access cuts shall be rounded to a minimum radius of six (6) inches.
5. Mark and save sections of plating and associated stiffeners removed for reinstallation. Ensure that the marking provides that removed sections are returned to their original location and orientation.
6. The Contractor shall repair, at his sole expense, any damage or deformation of the hull structure, beams, girders, stiffeners, or other similar items that occur as the result of load handling operations or any aspect of the Work.

D. STEEL FAIRNESS CRITERIA

1. The following table gives the maximum acceptable depth of unfairness of newly installed plating between frames, stiffeners, or deck beams. Depth of unfairness is measured by placing a straight edge, three (3) times the frame, stiffener, or beam spacing in length, across the plating between frames, stiffeners, or deck beams. The depth of the maximum allowed hump or hollow is then measured from the straight edge thus applied.

### STEEL PLATE FAIRNESS CRITERIA

STIFFENER SPACING	MISCELLANEOUS INTERIOR BULKHEADS, DECK HOUSE SIDES & TOPS, MISCELLANEOUS FLATS				ALL SHELL & DECK PLATING INCLUDING F.P.K. & GUARD, CURTAIN PLATING, VEHICLE, PASSENGER & TEXAS DECKS & MAIN BULKHEADS				
	7.65 # ( <sup>3</sup> / <sub>16</sub> " )	10.2 # ( <sup>1</sup> / <sub>4</sub> " )	12.75 # ( <sup>5</sup> / <sub>16</sub> " )	15.3 # ( <sup>3</sup> / <sub>8</sub> " )	7.65 # ( <sup>3</sup> / <sub>16</sub> " )	10.2 # ( <sup>1</sup> / <sub>4</sub> " )	12.75 # ( <sup>5</sup> / <sub>16</sub> " )	15.3 # ( <sup>3</sup> / <sub>8</sub> " )	20.4 # ( <sup>1</sup> / <sub>2</sub> " )
28"	3/8"	3/8"	3/8"	5/16"	5/16"	5/16"	5/16"	5/16"	5/16"
26"	3/8"	3/8"	5/16"	5/16"	5/16"	5/16"	5/16"	5/16"	5/16"
24"	5/16"	5/16"	5/16"	1/4"	5/16"	5/16"	5/16"	5/16"	1/4"
22"	5/16"	5/16"	1/4"	1/4"	5/16"	5/16"	1/4"	1/4"	-
20"	5/16"	1/4"	1/4"	3/16"	1/4"	1/4"	1/4"	3/16"	-
18"	1/4"	1/4"	3/16"	3/16"	1/4"	3/16"	3/16"	3/16"	-
14"	3/16"	3/16"	3/16"	-	3/16"	3/16"	3/16"	-	-

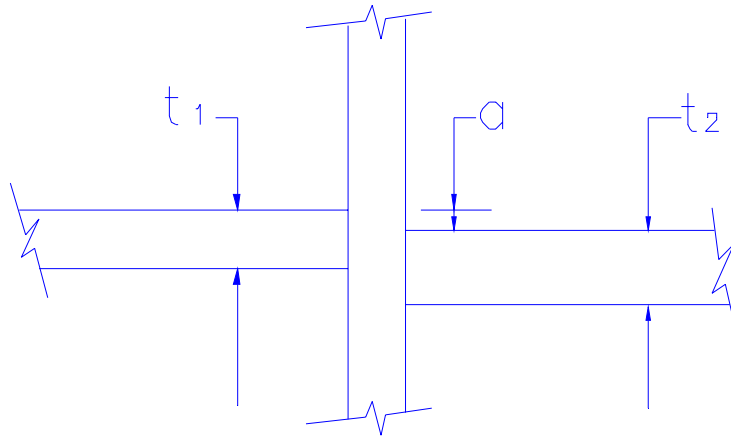
2. During deck plating installation, or other structural work, the Contractor shall exercise great care to assure that all surfaces are free from "oil can" deflection. Should "oil can" deflection occur, the Contractor shall remove such deflection by heat shrinking or mechanical displacement.
3. Where preventive measures are insufficient to control distortion and fairness tolerances are exceeded, straightening shall be employed to the minimum extent necessary to bring the plating within the tolerances specified.

#### E. BEAM STRAIGHTNESS CRITERIA

1. Frame, beam and stiffener bows in all structure installed in accordance with the Technical Specifications shall be corrected when it varies plus or minus from the designed or molded line in excess of <sup>3</sup>/<sub>8</sub>" or the following, whichever is less:
2. Span (feet)/(Depth (inches) x 4) = Tolerance (inches)
3. Span is the distance between the fixed ends at support structure, and Depth is the depth of a stiffening member measured from the underside of the flange. The measurement shall be taken from the most distorted position of the web.

F. ALIGNMENT CRITERIA (INTERCOSTAL STRUCTURE)

1. Structural components installed in accordance with the Technical Specification shall be aligned according to the following ASTM F 1053-87 criteria:



$a$  = allowable offset ;  $t$  = thickness;  $t_1 \leq t_2$

For principal longitudinal strength members:

$$a \leq \frac{1}{3} t_1$$

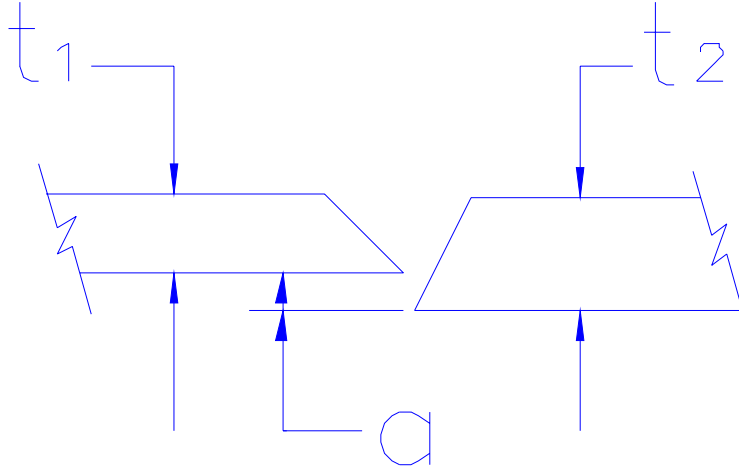
For other structural members:

$$a \leq \frac{1}{2} t_1$$

2. The alignment criteria applies to all structural alignments except butt joints including but not limited to: brackets; alignment of intercostal stiffeners, beams and girders; bulkheads, stanchions and pillars above or below a deck, or on opposite sides of a bulkhead, or the web of a beam or girder. Pipe stanchions of different diameter, and stanchions constructed from I or H sections, will be given special consideration.

G. ALIGNMENT CRITERIA (BUTT JOINTS)

1. Every effort should be made in assembly of structure to obtain 100% alignment on the molded line side of the members being joined, as shown below:
2. The maximum allowable offset tolerance shall be 15% of the thickness of the thinner member being joined (ASTM F 1053 criteria), as shown below:



$$a = \text{allowable offset} \leq (0.15) t_1; \quad t = \text{thickness}; \quad t_1 \leq t_2$$

H. WELDING

1. All welding/welder qualifications and welding procedures shall be the responsibility of the Contractor, and satisfy the requirements of 46 CFR 57, including ASME BPVC Section IX and shall conform to the requirements of Parts 2 and 3 of the ABS “Rules for Building and Classing Steel Vessels” (latest edition), or “Rules for Building and Classing Aluminum Vessels” (latest edition), Section 30.
2. Welders shall be certified through the performance of tests required by 46 CFR 57, ASME BPVC Section IX, or ABS tests Q1 through Q4, Table 2/3C.1 (for steel) or ABS tests Q1, Q2, Q4, Q5, & Table 30.6 (for aluminum), as applicable to the type of welding being performed by each individual.
3. No welder shall be assigned to a welding task aboard the Vessel, or to any structure or component being fabricated off the Vessel for future installation in or on the Vessel, until the WSF Representative has been provided with valid proof of current qualification. Should any welder’s certification expire, for any reason, at any time during the Contract period, that welder shall be immediately removed from the Work and shall not be re-employed on the Vessel, or its structure or components, until such time



as re-certification is obtained and documented to the satisfaction of the WSF Representative and the appropriate Authoritative Agency. The WSF Representative reserves the right to request and review any welder's certification, at any time, during the performance of the Work.

4. The Contractor is wholly responsible for developing all welding procedures and plate and shape preparation procedures to be used during the performance of the Contract and for ensuring compliance with the requirements of ABS and other cognizant Authoritative Agencies. The welding procedure, welder qualification and welder certification requirements outlined in this Work Item of the Technical Specification are applicable to, and form a part of every Work Item of this Technical Specification which may require the utilization of welding and welders.
5. Accomplish a 100% non-destructive testing (NDT) inspection of all new watertight bulkhead welds in accordance with the Contractor's approved procedures. All non-destructive weld testing shall be done in accordance with the ABS rules for Non-Destructive Inspection of Hull Welds (latest edition), using Class B weld criteria and this specification.
6. The American Welding Society's "Guide for Steel Hull Welding" will be used as a standard for visually inspecting the welding and fabrication workmanship.
7. Assembly welds shall be neat in appearance with all slag and spatter removed.

#### **4. ELECTRICAL INSTALLATION**

New and modified electrical systems shall meet the following general electrical requirements:

- A. Provide labor, material and equipment to mark each new or modified cable with its circuit number and cable type by use of a raised-letter embossed aluminum tag wherever a cable enters an enclosure of any type or penetrates a deck or bulkhead. Cables shall have identification labels on each side of deck or bulkhead penetrations and at any other location where both sides of the penetration are not readily visible for cable tracing. Care shall be taken that the correct cable tag is installed on each cable and in every location where required. Assign a unique cable number to each separate piece of cable installed by the contractor. For circuits that branch, or are connected at junction boxes, lighting fixture, etc., the basic cable number shall remain the same through the circuit. A bracketed dash number (-X) identifier shall be appended to each individual cable or wire starting with the lowest number at the power or signal source and increasing to the farthest load of the circuit. Provide new power/lighting typed panel directory cards for panels that have new or modified circuits. The circuit designation and load description of the circuit shall be typed on the card to correspond exactly with the final as-built condition of the vessel.

- B. Provide labor, material, and equipment to mark each individual wire for all new or modified circuits with identification floaters. Floaters will not be required for power or lighting cables. These floaters shall be provided and installed and be white polyolefin with permanent black typewritten lettering. The floaters shall be RAYCHEM-TMS (Terminal Marker System) or equal. Hand written letters or wire marker tape floaters will not be accepted. The correct circuit number shall be indicated on one line of each floater. On the second line of the floater, the terminal identification number shall be shown. The terminal identification number shall consist of the termination block and the termination point identification and the individual conductor identifier within the cable. Spare conductors and jumpers shall also be fully identified by this method.
- C. All control wiring terminations shall be made to terminal boards using ring lugs under compression terminal connections. No more than two wire terminations shall be placed under each screw of a terminal board exclusive of jumpers. All terminal lugs shall be installed using a manufacturers approved controlled-cycle crimping device.
- D. Each new or modified cable shall be tested for continuity. Record the origin and destination terminal designations to verify agreement with drawings for new, modified and/or relocated equipment and the approved electrical drawings. Record the date each circuit is checked, calibration date of the test equipment and the name of the person performing the test. Record actual resistance values observed during each test rather than noting that the value is satisfactory. After testing is complete, restore the system to operational status.
- E. All cable provided and installed by the Contractor shall be Low Smoke per Mil-C-24643A. Open up and restore existing cable transits and wireways as necessary. Provide new penetrations when needed. Bulkhead and deck cable penetrations shall maintain the watertight and fire rating of the boundaries penetrated and shall be installed and suitably protected to satisfy USCG requirements. Provide new cable to reconnect existing equipment that was relocated due to this modification, if the existing cable is too short. Remove all existing cable rendered useless by this modification. There shall be no more than two (2) cables entering any relocated or reconnected light fixture.
- F. In locations where cables will penetrate a bulkhead or deck, a USCG approved method, shall be utilized. In locations where stuffing tubes are used, the clear distance between adjacent stuffing tubes shall be no less than one and one half (1-1/2) the diameters of the largest stuffing tube of the two. Cables transiting bulkheads and decks shall maintain the fire-tight/water-tight capability of the bulkhead or deck as existing.
- G. All new cable banding, and replacement of existing cable banding where disturbed by the work, for interior and exterior, shall be stainless steel, using flexible channel rubber between the banding material and the cable. The use of nylon ty-

laps as cable retention devices will not be allowed. Unless otherwise specified, cable shall be installed in accordance with IEEE Standard 45, Clause 10 (except 10.11) and 13, and 46 CFR 111.60.

- H. Route new cables in existing wire ways as much as practical. All new exterior cable hangers, clips and attachments shall be stainless steel. The entire vehicle deck, curtain plate, machinery casing exterior and the underside of the passenger deck shall be considered exterior surfaces.
- I. All new fiber optic cable installations, will be tested to the following requirements.
  - a) Test Equipment requirements. Optical time domain reflectometer (OTDR). The OTDR is used for estimating the attenuation rate of a fiber, and locating the nature and location of defects in an optical link.
  - b) Specified Limits. The cable is considered satisfactory if the maximum measured attenuation for each fiber does not exceed the vendor's attenuation data by greater than 1 db/km.
  - c) Acceptance/pre-installation tests. Fiber optic cable and associated components shall undergo visual inspection prior to installation in the cableways to verify that it is mechanically sound. Inspect fiber optic cable with OTDR to verify it is optically sound and within specified limits.
  - d) Installation tests. After the cable is installed in the cableways, the pre-installation tests shall be repeated to verify that fibers were not broken or damaged when the cable was pulled through the cableways.
  - e) Post-Installation tests. After all fiber optic cable topology links have been installed, tests using optical inspection with OTDR, shall be conducted to verify that the end-to-end attenuation of the fiber optic cable topology is within specified limits.

## **5. MECHANICAL INSTALLATION - PIPING**

- A. Unless otherwise specified by the Technical Specification, system design, material selection, installation procedures, and testing for all piping systems shall be as required by; 46 CFR §'s 56, 57 and 58, ASTM Standard F 1155-88, The World Health Organization (WHO) "Guide to Ship Sanitation", and United States Public Health Service (USPHS) "Handbook On Sanitation Of Vessel Construction", as is applicable to the Work. Should there be conflict between the requirements of the Technical Specification, ASTM Standard F 1155-88, and 46 CFR §'s 56, 57 and 58; the latter shall prevail except in the case of material selection, then the more stringent shall prevail.

- B. All new and modified piping system's design and placements shall permit:
1. Easy access to valves and components for both operation and maintenance.
  2. Free passage along walkways and ladder ways.
  3. Free access to perform other system's operational and routine maintenance.
  4. Free access to all doors, hatches, ladders, openings, tank accesses, strainers, sea chests, treatment tanks, etc.
  5. Free access for the ready removal of Vessel equipment and system components for inspection servicing, repair, and/or replacement.
- C. Piping systems shall not pass through spaces predominantly equipped with electrical equipment unless directly associated with equipment installed in those spaces. When it is necessary to pass through or enter such spaces, piping shall not contain mechanical joints unless it can be demonstrated that the installation is impractical.
- D. Piping systems shall not pass directly above electrical switchboards, panels, disconnects, switches, motor starters, or Motor Control Centers. In no cases shall piping be routed over the EOS Control Console.
- E. Provide pipe hangers in accordance with ASTM Standard F 708-92, Figure 1, Split Cap Hangers and as follows:
1. All piping shall be adequately supported by hangers suitable for the material and service. "Piggybacking" of pipe hangers shall not be allowed unless specifically approved in writing by the WSF Representative.
  2. Hangers shall be continuously welded to the basic structure of the Vessel and shall not be welded to any pipe. Attachments to structural plate shall only be opposite from framing attachments. Care shall be taken to ensure that piping and hangers are of compatible material. Where dissimilar materials exist, hangers shall be isolated with a USCG approved isolation material.
- F. Unless otherwise specified in the Technical Specification, piping penetrating decks or bulkheads shall be provided with tight fitting, extra heavy collars or sleeve fittings (similar to a coupling fitting as set forth in ASTM Standard F 682-82a, Type II), at all locations. All such sleeves or collars shall be fabricated with a vent hole, which shall be closed after all welding, brazing, and/or soldering is complete. Collars or sleeves shall be continuously welded to both sides of the structure. Pipes shall be continuously welded, brazed, or soldered, as appropriate, to both ends of the sleeve.
- G. All piping penetrations through "B" and "C" type accommodation space bulkheads, as defined in USCG NVIC 9-97, shall be closed with tight fitting stainless steel faceplates.

- H. Steam supply and refrigeration piping/tubing penetrating decks and/or bulkheads shall be thermally isolated from steel or aluminum plating by the use of a ROMAC or equal compression type coupling to prevent thermal loss from the system.
- I. No pipe thread sealant tape shall be used on any fitting for final assembly.
- J. Instrumentation piping system components and materials shall be selected, supplied, and installed in accordance with ASTM Standard F 721-81, and the Technical Specification. Control air, gage, and impulse tubing shall be minimum ¼ inch OD, Type 316 stainless steel.
- K. Tubing and hose systems shall be designed and supplied utilizing PARKER Multi-Clamp Tube Clamping System, or equal, throughout the Vessel. Stacking will be permitted to conserve space, however, each tube or hose in a stacked system shall be clearly and permanently identified at intervals not to exceed twenty (20) feet and at least once in each compartment.
- L. Valve operators may be installed under deck plating or grating levels. In these instances, the operators must be within six (6) inches of the deck or grating level, readily accessible, and labeled on deck level.
- M. Handwheels for valves located below deck plates and gratings, except as noted otherwise in the Technical Specification, shall not extend through the deck plate or grating and create a tripping hazard.
- N. Where remote or direct valve operators are installed under deck plating or grating, hinged access doors shall be provided to readily access the operators through the deck plates or gratings. Valve operators shall be free of interference through the entire cycle of their operation.
- O. Where remote operators are required, rigid rod type remote valve operators manufactured by B.W. ELLIOTT MANUFACTURING CO. INC. or equal, shall be provided. Rigid rod type operators may be used in conjunction with universal joints up to a maximum of 30 degree offset. Gearboxes shall be used for offsets beyond 30 degrees. Where rigid rod cannot be used, flexible shaft type remote valve operators manufactured by B.W. ELLIOTT MANUFACTURING CO. INC. or equal shall be provided.
- P. Drains from equipment shall not be less than ¾ inch IPS.
- Q. Flange gaskets shall be GARLOCK Blue-Gard 3300 in water and steam service and GARLOCK Blue-Gard 3000 in fuel, lubricating, and hydraulic oil service. All gasket material shall be certified asbestos free.
- R. The use of Association of American Railroad (AAR) fittings in lieu of Extra Heavy 300 pound malleable iron fittings is prohibited.

- S. Flexible hose shall be certified to SAE J1942 unless directed otherwise in the Technical Specification. All flexible connections shall be fabricated using AEROQUIP FC-234 AQP hose for sizes less than one (1) inch and AEROQUIP 2651 hose for sizes one (1) inch and above on fuel and lube oil systems; and AEROQUIP 2651 hose on all other systems, except high pressure hydraulic steering hoses which shall be AEROQUIP type currently certified to SAE J1942 for the intended service. All hose assemblies shall be fabricated using AEROQUIP reusable fittings. Hose fittings shall be certified to SAE J1475.
- T. During the fabrication, installation and testing of all piping systems, openings shall be kept tightly sealed to insure foreign matter and moisture exclusion. This includes components such as valves, pumps, coolers, heaters and instruments. Tape alone or the use of wood blanks is not an acceptable means of foreign matter and moisture exclusion. Use metal or plastic caps, plugs and blanks, or metal plugs and gags as appropriate to limit system and component contamination.
- U. All piping and tubing must be mounted without springing or forcing into place. Flange faces shall be parallel (plus 1/32 inch, minus 0) before bolting. All pump face to flange fit up shall be demonstrated to the WSF Representative prior to final bolting.
- V. Provide flanged takedown joints in piping 2-½ inch and over and unions in piping 2 inch and under, unless specifically directed otherwise by the Technical Specification. Flanges in piping shall conform to ANSI Standards for the appropriate service.
- W. Where a steel flange is used with a cast iron or bronze flange, the steel flange shall have a flat face and a full-face gasket shall be used.
- X. Piping and/or tubing is not permitted in or on electrical cableway hangers, nor may they share deck or bulkhead penetrations.
- Y. Screwed plugs or caps shall be bronze for either ferrous or non-ferrous materials.
- Z. Pipe runs shall be as direct as possible, with as few bends, elbows and tees as practicable.
- AA. Pipe and tubing machine bending processes shall be used wherever possible, unless specified otherwise in the Technical Specification, or by having been satisfactorily demonstrated to and approved by the WSF Representative that the use of elbows is more practical at a particular location(s).
- BB. To accomplish change of direction, machine bend pipe and tube to a minimum radius of five (5) times the nominal pipe diameter for pipe two (2) inches IPS and below, and Cu-Ni tube. Stainless steel tubing may be bent to a radius of five (5) times the nominal tube diameter. Copper tubing may be bent to a radius of three (3) times the nominal tube diameter.
- CC. Control air, gauge, and impulse tubing may be hand bent or machine bent to a radius of five (5) times the nominal diameter. Hand bending tube without the use of an appropriately sized tubing bender is prohibited.

- DD. Pipe welding and brazing shall comply with the rules and regulations of all applicable Authoritative Agencies, such as 46CFR § 57 and the details of ASTM Standard F 722-82.
  - EE. Mitred joints or fittings are prohibited.
  - FF. Unless otherwise specified, ferrous pipe with welded fittings, which are required to be galvanized, shall be Hot-Dip galvanized after fabrication. Where galvanizing is damaged during installation, GALVICON or equal, brush-on galvanizing coating shall be applied to the damaged areas after appropriate surface preparation.
  - GG. Pop rivets shall not be used in place of threaded fasteners without the prior written approval of the WSF Representative, unless specifically called for in a Work Item. All exterior fasteners shall be Type 316 stainless steel. All interior fasteners shall be corrosion resistant, grade 5 or better. All nuts shall be Nylok or equal, except for general lighting and main cableways.
  - HH. All new or modified piping, piping appurtenances, and associated equipment shall be thoroughly cleaned after fabrication and prior to installation in the Vessel. After installation, each new or modified system shall be thoroughly cleaned and flushed of all foreign material utilizing the normal system medium or a WSF approved substitute.
- II. FLUID DESIGN VELOCITIES
- 1. Fluid velocity criteria given in Table, FLUID DESIGN VELOCITIES, shall be used in sizing each associated piping system designed by the Contractor.

## FLUID DESIGN VELOCITIES

Type of Service	Nominal Pipe Diameter (in)	Maximum Velocity (fps)
Fuel Oil Suction	$2 \times \text{SQRT}(D)$	7
Fuel Oil Discharge	$5 \times \text{SQRT}(D)$	12
Lubricating Oil Suction	$1 \times \text{SQRT}(D)$	4
Lubricating Oil Discharge	$2 \times \text{SQRT}(D)$	6
Steam	$50 \times \text{SQRT}(D)$	150
Condensate Drains	$0.3 \times \text{SQRT}(D)$	1
Sea Water Suction	$3 \times \text{SQRT}(D)$	**
Sea Water Discharge	$5 \times \text{SQRT}(D)$	**
Freshwater Suction	$3 \times \text{SQRT}(D)$	15
Freshwater Discharge	$5 \times \text{SQRT}(D)$	20

Where: (D) = pipe internal diameter in inches

\*\* = 9 fps for galvanized steel and 9 fps for CuNi pipe except for occasional use service systems

- JJ. Diesel fuel systems shall be located at least 18 inches away from surfaces which have temperatures under their insulation or lagging in excess of 450°F. Lubricating oil systems shall be located at least 18 inches away from surfaces which have temperatures under their insulation or lagging in excess of 650°F. Hydraulic oil systems shall be located at least 18 inches away from surfaces which have temperatures under their insulation or lagging in excess of 650°F

### KK. DRAIN SYSTEM DESIGN and INSTALLATION REQUIREMENTS

1. Route drain piping as direct as possible. Sanitary and other drain system piping shall be installed with readily accessible 1½ inch IPS clean-out caps/fittings suitable for use with a plumber's snake or pressurized water hose and in sufficient number to ensure clear access to each run of pipe from at least one end. Caps shall be of a compatible material, or bronze. Clean outs shall be installed in the direction of flow of the system media, be of sufficient length so as to extend beyond the installed pipe insulation coverings and be located to allow easy accessibility and thorough cleaning



of the system. There shall be no clean-out connections installed or provided within any food service/preparation areas.

2. All plumbing fixture drains shall be independently trapped.
3. Use long radius and sweep type fittings for all drains serving toilet fixtures.
4. Branch connections to athwartship drains which discharge to both sides of the vessel shall be made at 90 degrees using double sweep fittings.
5. Where drains are combined, either wye or sweep tee fittings shall be used to facilitate flow.
6. Deck drains shall be fitted with removable brass strainer plates having a free area equal to no less than twice the cross-section of the drain pipe. Strainers shall be flush with the finished deck and properly secured with brass or stainless steel fasteners as applicable.
7. Slope piping in each system to drain naturally to the low end.

LL. FLEXIBLE CONNECTIONS

1. Piping connected to rotating and reciprocating machinery and resiliently mounted equipment shall have flexible connections provided which are located as close to the machinery/equipment as is possible.
2. Except where specifically otherwise noted, all hose assembly end connections shall be; flanged for sizes two (2) inches and above, with SAE 37° (JIC) flare swivel nuts on each end for sizes under two (2) inches.
3. Diesel oil system flexible connections shall be selected and installed as required by 46CFR § 56.60-25 with SAE 37° (JIC) flare swivel nuts on each end.

MM. WELDING AND BRAZING

1. Pipe welding and brazing shall comply with the rules and regulations of all applicable Authoritative Agencies, such as 46CFR § 57; the details of ASTM Standard F 722-82 (1988); F1076 (1992); and the WSF Structural Installation Standard. Welding performance and procedure qualifications shall meet the requirements of 46CFR 57.01 through 57.05-3.
2. Butt welding of piping shall only be allowed on 2½ inch nominal and above.
3. Mitered joints are prohibited.
4. Brazing temperature shall not exceed the annealing temperature of the base pipe material, and in no case shall the brazing temperature range exceed 1300-1500°F for 90-10 copper nickel pipe and tubing. The Contractor shall employ the use of temperature indicating crayons (Temp. Sticks) to assure that the maximum temperature as stated above is not exceeded.

5. All soldering of copper pipe or tubing joints shall be accomplished using 95-5 Tin-Antimony solder materials in accordance with ASTM Standard B32.

NN. CLEANING, FLUSHING, AND DISINFECTION

1. All new or modified piping, piping appurtenances, and associated equipment shall be thoroughly cleaned after fabrication and prior to installation in the vessel. After installation, each new or modified system shall be thoroughly cleaned and flushed of all foreign material utilizing the normal system medium or a WSF approved substitute.
2. Internal surfaces of newly fabricated fuel oil, lube oil, and hydraulic fluid piping shall be cleaned by acid pickling, then oiled to prevent corrosion. After piping systems have been pickled and oiled, all open ends shall be sealed. System cleaning shall be accomplished using Contractor furnished flushing machines and heaters capable of circulating system fluids. The Reynolds Number for the flowing condition during flushing shall be greater than 4000 to insure that the flow is turbulent.

Reynolds number is the product of **Fluid Velocity**, (V in ft./sec.) and the pipe **Inside Diameter**, (D in ft.) divided by the **Kinematic Viscosity**, (v in ft.<sup>2</sup>/sec.). Normally kinematic viscosity is given in units of Centistokes. To convert Centistokes to ft.<sup>2</sup>/sec, multiply Centistokes by 0.0000176 (1.076x10<sup>-5</sup>)

$$Re = \frac{V D}{v}$$

3. During flushing of ferrous piping, the complete piping system, along its full length, shall be continuously vibrated using pneumatic or electric motor driven line vibrators of the temporary in-line type, which shall be firmly affixed to the piping throughout the cleaning cycle. Temporary jumpers shall be installed so that all portions of the system are flushed.
4. Hydraulic oil, fuel oil and lube oil systems shall be flushed in accordance with the Technical Specification. In the event no flushing procedure is specified the following guidance is to be followed: Pumping shall be accomplished using contractor furnished pumps. Fit temporary strainers in systems while systems are being flushed. Temporary strainers shall be lined with ten (10) micron filter bags with magnets, and shall be inspected every two (2) hours during flushing activities. Clean temporary strainers periodically while changing filter bags, and continue flushing until fluid is clean in accordance with Reference (J.) to NAS Class 8 or better.
5. Before placing the potable water system in service, it shall be first soaked and flushed to remove flux, and subsequently be cleaned, disinfected,

flushed and certified in accordance with the The World Health Organization (WHO) Guide to Ship Sanitation", and United States Public Health Service (USPHS) "Handbook on Sanitation of Vessel Construction". Should it be necessary to reopen the potable water system prior to redelivery of the vessel, the entire system shall be re-cleaned and re-disinfected, with a new Certificate of Disinfection provided to the WSF Representative.

## **6. MECHANICAL INSTALLATION - VENTILATION**

- A. Vent ductwork installations shall be hot dipped galvanized sheet steel. Touch up all damaged or destroyed galvanizing with approved cold galvanizing compound after fabrication.
- B. All vent ductwork shall be smooth inside with no protruding edges. Ducts shall have riveted, welded, or hooked seams. Rivets shall be of minimum length required to seal seams.
- C. Bends and elbows in vent ductwork shall be fabricated with a throat radius of at least ½ times the diameter or width. Where this is not possible due to space limitations, a vaned turn or splitter shall be used to give quiet and efficient operation.
- D. Reductions in vent ductwork size shall be accomplished with transition pieces. Converging transition pieces shall have a maximum 30° included angle. Diverging transition pieces shall have a maximum 15° included angle. If the transition angle exceeds the above requirements, splitters shall be fitted to reduce the expansion angle.
- E. Ventilation ductwork may be round, flat oval, or rectangular. The minimum thickness of ventilation duct material shall be in accordance with the following Table, unless otherwise specified. The size is determined by the diameter for round duct and the maximum dimension for rectangular or flat oval duct.

<b>VENTILATION DUCT THICKNESS REQUIREMENTS</b>		
<b>SIZE</b>	<b>THICKNESS INCHES</b>	
	<b>STEEL</b>	<b>ALUM</b>
Less than 12 inches	0.030"	0.040"
12.5 to 18 inches	0.036"	0.050"
18.5 to 30 inches	0.048"	0.060"
Above 30 inches	0.060"	0.080"
Exposed duct, weather decks, areas subject to mechanical damage	0.060"	0.080"

- F. Install ductwork tight to overhead deck beams. Routing of overhead ductwork shall not violate headroom space.
- G. All joints in the ductwork shall be sealed airtight with a USCG approved fire resistant, high velocity duct sealer.
- H. Provide adjustable system balancing dampers in all branch supply, return, and exhaust ductwork.
- I. All ductwork shall be properly supported from Vessel primary structure with vent duct supports and hangers shall be insulated from the duct with cloth inserted neoprene rubber.
- J. All Vessel and/or equipment ventilation and piping systems that are provided new, modified, or relocated by the Contract Work shall have all associated components, equipment, ductwork, dampers, diffusers, operators, pipes, valves, and appurtenances labeled to match the existing system labeling methodology.

**(END)**